



UNIVERSIDADE ESTADUAL PAULISTA  
"JÚLIO DE MESQUITA FILHO"  
Campus de Araçatuba

**GIOVANA MARIA ZEINE DOS SANTOS**

**The influence of composite resins fluorescence  
intensity in the retreatment of direct veneers  
using different removal methods**

Araçatuba

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Trabalho de Conclusão de Curso apresentado à Faculdade de Odontologia de Araçatuba da Universidade Estadual Paulista “Júlio de Mesquita Filho” – Unesp, como parte dos requisitos para a obtenção do título de Bacharel em Odontologia

Orientadora: Profa. Dra. Ticiane Cestari Fagundes

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## **ABSTRACT**

During the retreatment of direct veneers, the dental surgeon finds it difficult to remove all the restorative material without causing unnecessary wear to the healthy tooth structure. For this reason, this laboratory study evaluated the influence of fluorescence intensity of composite resins on additional tooth wear or presence of restorative material in different dental thirds during retreatment of direct veneers. Sixty bovine incisors had their crown dimensions reduced to 10x8mm. Teeth were divided according to fluorescence intensity of composites: low-L (TPH spectrum), medium-M (Opallis) and high-H (Essentia). Teeth were divided according to removal methods: conventional-CON and fluorescence-aided identification technique-FIT. Specimens were scanned (T0), received veneer preparation and were scanned again (T1). After restorations, composite was removed, and teeth were scanned (T2). Measurements between T1 and T2 were performed for: additional wear, presence of residues areas, average between additional wear and presence of residues. Kruskal Wallis, Mann-Whitney, Friedman, two-way ANOVA, and post-Tukey tests were performed ( $\alpha < 0.05$ ). Comparing composite resins, smaller area of additional wear and greater residues presence was found for H compared to L for both techniques, in cervical third. Comparing removal methods, FIT presented greater additional wear than CON for L and M, in middle and cervical thirds. Incisal presented greater additional wear than other thirds. It was concluded that composite resin with high fluorescence intensity removed with FIT promoted less tooth wear. Incisal third was the most affected in direct veneer removal procedures.

**Keyword:** Composite resin. Fluorescence. Resin removal.

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## LIST OF ABBREVIATIONS, SYMBOLS AND ACRONYMS

%	percentage
<	smaller
>	bigger
±	more or less
3D	three-dimensional
CON	conventional method
FIT	Fluorescence-aided identification technique
LED	light emitting diode
H-CON	High fluorescence with conventional technique
H-FIT	High fluorescence with the technique FIT
L-CON	Low fluorescence with conventional technique
L-FIT	Low fluorescence with the technique FIT
M-CON	Medium fluorescence with conventional technique
M-FIT	Medium fluorescence with the technique FIT
mm	millimeter
mm <sup>2</sup>	square millimeter
nm	nanometer
T0	Initial scan
T1	Scanning after veneer preparation
T2	Scanning after removal of composite resin veneers
UV	Ultraviolet light

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## 1 INTRODUCTION

The aim of treatment with direct veneers is to change color and contour of teeth, or even improve the appearance of mal positioned teeth.<sup>1</sup> Composite resin veneers have advantages over ceramic veneers, such as: adhesion, reduced cost, possibility of execution in a single session and they are easily repaired when small failures occur.<sup>1</sup> However, composite resin veneers present disadvantages such as: low compressive strength, loss of gloss, surface staining and alteration of the initial texture.<sup>1,2</sup>

In many cases, retreatment of these veneers is necessary, being a challenge to clinicians differentiate the restorative material from the dental tissue, due to their similarities.<sup>3</sup> During the removal procedure, there is a risk of causing additional wear to healthy tooth structure.<sup>4,5</sup> On the other hand, bond strength and longevity of a new restoration may be damaged if large amounts of composite resin residues are not removed.<sup>6,7</sup> Several methods and equipment have been developed to assist removal of composite resin restoration, avoiding unnecessary wear or material permanence on teeth.<sup>4,5,8-16</sup> In this context, fluorescence-aided identification technique (FIT) may be indicated for stimulating fluorescent particles present in composite resin, facilitating their visualization and removal. A high-speed handpiece that emits ultraviolet (UV) light at an intensity of 350-400 nm can be used in this technique.<sup>4,17,18</sup>

Nevertheless, for this technique to be effective, the use of fluorescent resins is essential.<sup>13</sup> Currently, composite resins with different fluorescence intensities (high, medium and low) are found. They are crucial to ensure the success of esthetic treatments, since it is an optical property present in natural teeth that must be reproduced in restorations.<sup>19</sup>

The literature presents a study that evaluated a technique that utilized a UV LED to evidence only presence of composite resin during their removal, revealing the presence of resin to all types of fluorescence intensity of composite resins.<sup>20</sup> Based on some results, the use of UV illumination can be a useful technique for determining if composite resin has been removed completely. Furthermore, dental enamel is known to have different thicknesses along the dental thirds, thus caution must be taken during removal of composite resin veneers to avoid enamel wear and dentin exposure.<sup>21,22</sup>

There is no literature using digital scanning to evaluate the enamel

damage or remaining resin on different tooth thirds when the removal of fluorescent composite resin in anterior veneers is necessary.

## **2 OBJECTIVES**

The purpose of this study was to evaluate the influence of composite resins fluorescence intensity on tooth wear and/or presence of restorative material in different thirds, during removal of direct veneers using FIT. The null hypotheses tested were: (I) there will be no statistical difference between removal methods when the same composite resin is used, considering same dental third; (II) there will be no statistical difference between fluorescence intensity of composite resins when the same removal method is used, considering same dental third; (III) there will be no statistical difference between dental thirds when the same composite resin and veneer removal method are used.

### 3 METHODS AND MATERIALS

#### 3.1 Study design

The project was submitted and approved by the local animal ethics committee (Process FOA nº 0525-2021). Sixty bovine teeth aged between 24 and 30 months were selected, considering the following exclusion criteria: stains, morphological changes in clinical crown and enamel cracks. Teeth were distributed in 6 groups, according to intensity of composite resin and removal method used. They were submitted to analysis of dimensional alterations referring to each dental third. Three experimental factors were investigated in this study: (I) Composite resins in three levels: high, medium and low fluorescence intensity (II) Removal methods in two levels: conventional (CON) and FIT (III) Dental thirds at three levels: incisal, middle and cervical.

#### 3.2 Specimens' fabrication

Sixty teeth corresponding to A3 shade (VITA Classical Shade Scale, VITA Zahnfabrik, Bad Säckingen, Germany) were selected using a spectrophotometer (VITA Easyshade Advance, VITA Zahnfabrik, Bad Säckingen, Germany). Teeth were cleaned with periodontal cures and submitted to prophylaxis with pumice and water. Dimensions of crowns were manually reduced to 10 x 8 mm, simulating the size of a human maxillary central incisor.<sup>23</sup> To facilitate the manipulation of samples, their roots were sectioned, reducing the total height (crown and root) to 18 mm.<sup>4</sup> Initial scanning (T0) of all specimens was performed with an intraoral scanner (TRIOS, 3Shape, Copenhagen, Denmark). Transparent matrices were made using addition silicone (Elite Transparen, Zhermack SpA, Badia Polesine, RO, Italy) to standardize the thickness of composite resin at the time of restoration.<sup>4</sup>

Teeth were prepared with a conventional high-speed handpiece, simulating the characteristics of preparation for direct resin composite veneer. Orientation grooves were performed with a depth of 0.3 mm (#4141, KG Sorensen Ind. E Com. Ltda., São Paulo, Brazil) and then merged using conical diamond burs (#4138, #4138F and #4138FF, KG Sorensen Ind. E Com. Ltda, São Paulo, Brazil). Diamond burs were replaced with new ones every 5 teeth.<sup>24</sup> The cervical outline was a shallow chamfer 0.1 mm thick.<sup>4</sup> The cervical and proximal contours, as well as the buccal surface, were

established in enamel. The incisal edge was not performed due to the limitation of the specimen does not have an incisal border.<sup>4</sup> Specimens were scanned again (T1) and the average amount of wear between T0 and T1 was measured with 3D Viewer software (3Shape, Copenhagen, Denmark) to check the standardization of preparations.<sup>4</sup> Specimens with a volumetric change of 10% above or below the mean were excluded from the study.<sup>4</sup>

Teeth were divided into 6 groups according to fluorescence intensity of composite resin and veneer removal method, as follow: H-CON, M-CON, L-CON, H-FIT, M-FIT, L-FIT. Three composite resins with different fluorescence intensities were used: low-L (TPH spectrum, A3, Dentsply Sirona, York, Penn, USA), medium-M (Opallis, EA3, FGM dental products, Joinville, SC, Brazil) and high-H (Essentia, Dark Enamel, GC dental corp, Tokyo, Japan).<sup>19</sup> Removal of veneers was performed with a high speed handpiece (Cobra, Gnatus, Ribeirão Preto, Brazil) that allows the use of CON technique and FIT.

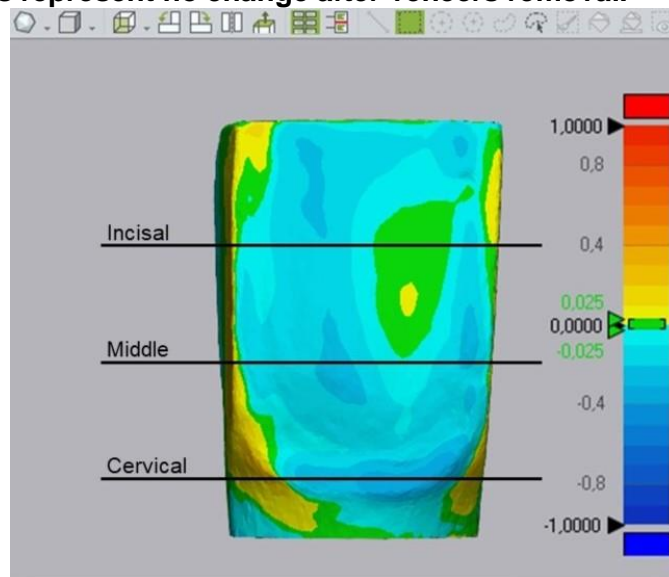
Teeth surfaces were conditioned with 37% phosphoric acid (3M ESPE, St. Paul MN USA) for 30 seconds on enamel and then washed with water jets and air-dried. Universal adhesive system (Single Bond Universal, 3M ESPE, St. Paul, MN, USA) was applied, the solvent was evaporated with air jets and specimens were light-cured (Radi-Cal Light Curing, Victoria, Australia) for 20 seconds. Veneers were performed according to composite resins described above, using the matrices made prior to teeth preparation and light-cured for 40 seconds with the same device. Veneers removal was performed by another operator according to groups mentioned above. For both removal methods, the same conical diamond burs were used, establishing a working time of a maximum of 10 minutes per specimen. Then, the final scan (T2) was performed.

### **3.3 Analysis of dimensional changes**

Scans at T2 and T1 were overlapped to measure areas of additional tooth wear<sup>25</sup> and presence of composite resin residues using a software (Geomagic Control X, 3D Systems, Rock Hill, South Carolina, USA). Dental crowns were divided into thirds measuring approximately  $2.6 \pm 0.1$  mm to analyze areas of additional tooth wear and presence of composite resin residues per third (cervical, medium, and incisal). Areas were distinguished by different colors: blue representing areas of additional wear; yellow, areas of presence of residues and green, areas that had no dimensional

changes (Figure 1). Thus, when selecting the area of interest, numerical values were obtained for statistical analysis.<sup>4</sup> The average between additional wear and presence of residues between T2 and T1 was provided by the same software in all buccal surface. Negative values represented additional dental wear and positive values characterized presence of composite resin residue.<sup>4</sup> A tolerance of 0.025 mm was established for the overlap in the software, with variations described from -1 mm (wear of the remaining tooth) to +1 mm (presence of resin residues) in the histogram.<sup>4</sup>

**Figure 1- Overlapping of T1 and T2 scans in Geomagic Control X software. Division of crown into dental thirds measuring approximately  $2.6\pm 0.1$  mm. Blue areas represent additional wear; yellow areas represent composite resin residue; green areas represent no change after veneers removal.**



Source: prepared by the author (2024)

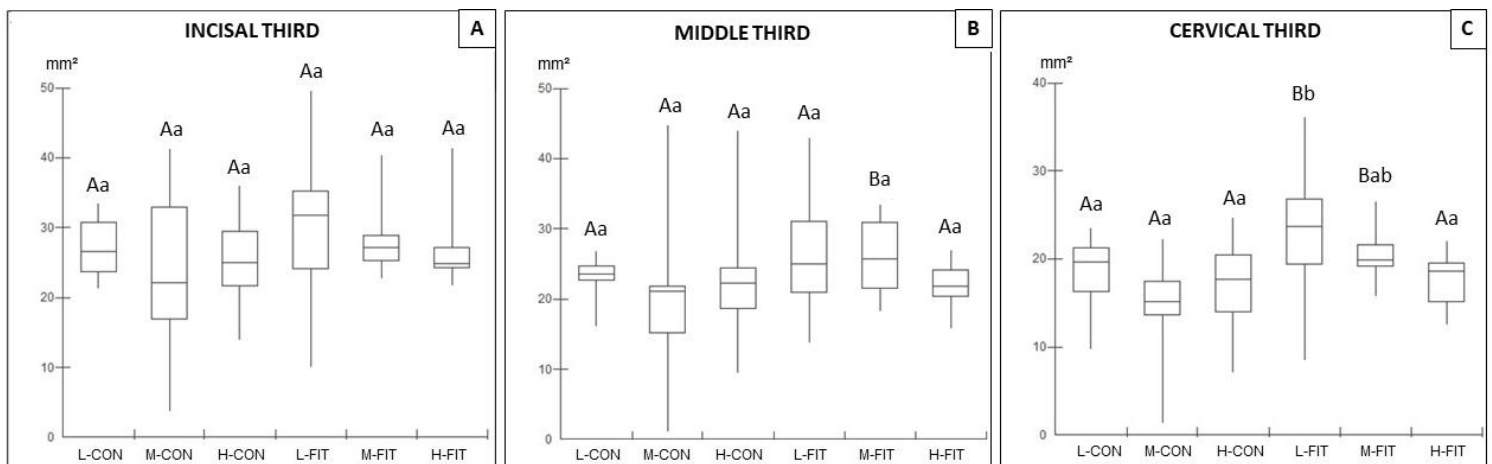
### 3.4 Statistical analyses

Shapiro-Wilk normality test were applied. Only data from fluorescence intensity of composite resins and average between tooth wear and presence of residues between T2 and T1 passed in normality test. Data from fluorescence intensity of composite resins were analyzed using one-way ANOVA and Tukey's post-test. Areas of additional tooth wear and presence of composite resin residues were submitted to the following tests: Kruskal-Wallis for comparison between composite resins; Mann-Whitney for comparison between removal methods; Friedman for comparison between dental thirds. The average between tooth wear and presence of residues between T2 and T1 was submitted to two-way ANOVA tests and Tukey's post-test. All analyzes were performed with a significance level of 5%.

## 4 RESULTS

Data from areas of additional tooth wear are shown in Graphic 1. Regarding removal methods, L-CON and M-CON presented smaller wear area in middle and cervical thirds, compared to L-FIT and M-FIT ( $p < 0.05$ ). Comparing composite resins with different fluorescence intensities, no differences were detected for CON removal method; however, L-FIT presented the largest wear area in cervical third, different from H-FIT ( $p < 0.05$ ) and similar to M-FIT ( $p > 0.05$ ). Comparing dental thirds, except for L-FIT, all other groups showed that incisal third had greater wear area, different from cervical third ( $p < 0.05$ ), and both showed no difference with middle third ( $p > 0.05$ ).

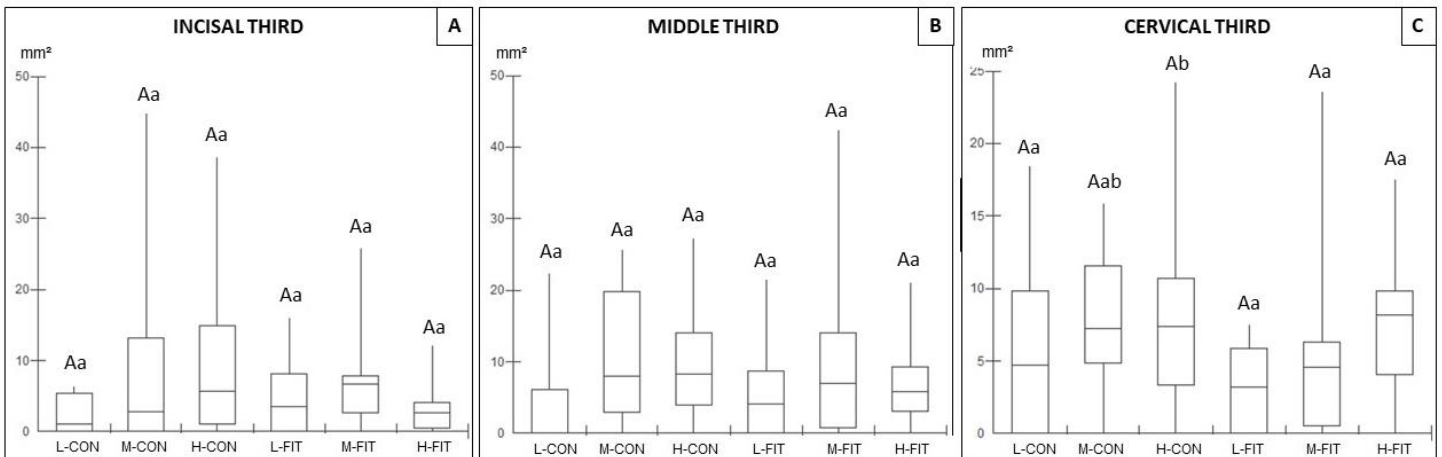
**Graphic 1- Medians and quartiles (25% and 75%) of the additional wear area analysis ( $\text{mm}^2$ ). Capital letters compare removal method within same composite resins. Lowercase letters compare composite resins, within same removal method.**



Source: prepared by the author (2024)

Data from areas of presence of composite resin residues are shown in Graphic 2. There were no differences between removal methods ( $p > 0.05$ ). Comparing composite resins with different fluorescence intensities, no differences were detected for FIT removal method; however, H-CON presented the largest residue area in cervical third, different from L-CON ( $p < 0.05$ ) and similar to M-CON ( $p > 0.05$ ). Regarding dental thirds, incisal third had a lower value than middle and cervical thirds in H-FIT ( $p < 0.05$ ).

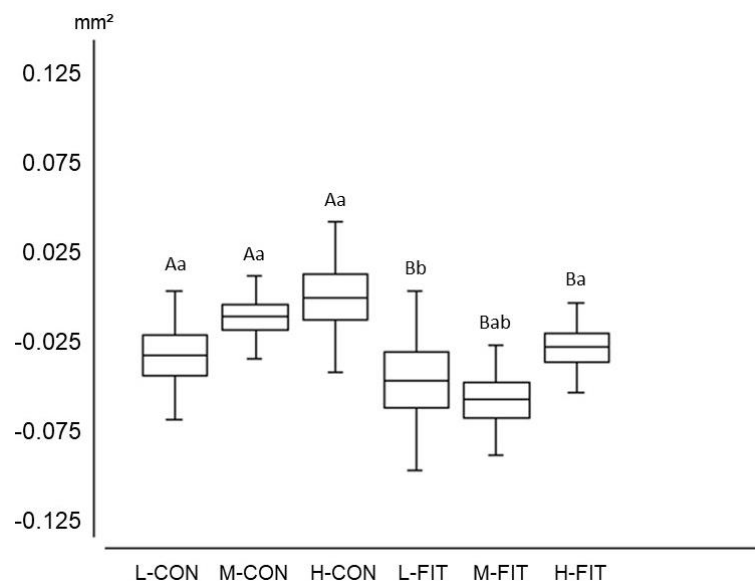
**Graphic 2- Medians and quartiles (25% and 75%) of presence of composite resin residues area analysis (mm<sup>2</sup>). Capital letters compare removal method within same composite resins. Lowercase letters compare composite resins, within same removal method.**



Source: prepared by the author (2024)

Data from average between additional tooth wear and presence of composite residues are shown in Graphic 3. Groups submitted to CON removal method showed less wear than groups submitted to FIT ( $p < 0.05$ ). Comparing composite resins, only L-FIT showed greater wear than H-FIT ( $p < 0.05$ ). As the software generates this data automatically for entire tooth, the analysis of dental thirds was not performed.

**Graphic 3- Mean and standard deviation of the analysis of the average between additional wear and the presence of resin residues (mm<sup>2</sup>). Capital letters compare removal method within same composite resins. Lowercase letters compare composite resins, within same removal method.**



Source: prepared by the author (2024)

## 5 DISCUSSION

To recognize direct composite resin veneers that are correctly shade-matched and well-placed by visual and tactile inspection alone may be a challenge. Many composite resins fluoresce under UV light, which can help dentists to detect resin material.

The use of digital technique to quantify areas of resin remaining and enamel removed have been the methodology used in several current studies.<sup>4,8-18</sup> Intraoral scanners have been suitable tools for detecting wear on tooth surface, demonstrating an accuracy of 97% when compared to computed microtomography.<sup>25</sup> The software used to measure dimensional changes between T1 and T2 ensured a rigorous analysis, such as demonstrated in other study,<sup>4</sup> in which a tolerance of 0.025 mm was defined for the overlapping of models, obtaining greater precision and veracity of results.

According to the results of present study, the first null hypothesis was rejected since there was a difference between direct veneers removal methods. FIT presented more additional wear than CON method when resins of low and medium intensity of fluorescence were used. When composites are illuminated at a wavelength of approximately  $398 \pm 5$  nm, certain fluorescent components cause the composite to appear brighter than tooth structure.<sup>16</sup> Probably, composite resins with lower fluorescence intensity could difficult the visualization and removal than resins with higher fluorescence intensities when using FIT. Some studies have demonstrated less tooth wear with the use of FIT during composite resin removal; however, they used flashlights that emitted wavelength UV light with the interval of 404 - 429 nm, and without varying the fluorescence of composite resins.<sup>8-16</sup> Furthermore, some of these studies performed resin removal in dark environments<sup>11,15,16</sup> or using yellow filter goggles,<sup>14,15</sup> such conditions did not represent clinical environment. It is worth noting that the wavelength UV light of the high-speed handpiece used in our study was 350 - 400 nm with artificial lighting. Results from other study indicated that the optimal excitation wavelength was 385-395 nm, while 460 nm was determined to be the mean emission maxima.<sup>20</sup> Using the same high-speed handpiece as in present study, during access preparation for retreatment of root canals, authors observed that there was a greater additional wear of the healthy tooth structure when FIT was used, corroborating with our results.<sup>19</sup>

The second null hypothesis was also rejected, as there was a difference of detected areas between intensity of composite resins fluorescence. It was observed that the fluorescence intensity of composite resin is inversely proportional to additional wear area when FIT is used in cervical third. It means that the lower is the intensity of composite resin, the greater is the tooth wear area. Furthermore, the group restored with high-intensity composite resin and submitted to CON method had the largest area of presence of residues in cervical third, possibly due to the difficulty in distinguishing between restorative material and dental tissue without any auxiliary identification method. In another study,<sup>20</sup> the results showed that UV light evidenced presence of resin residues regardless of their fluorescence intensity, however, our results indicate that low intensity resin is less evidenced by UV light, causing further wear to tooth structure.

It is worth mentioning that the methodology used in the present study, allows to obtain the total average between tooth wear and the presence of resin residues. This data has significant clinical relevance as that most groups had negative mean values, which prove that removal procedures promote additional wear to tooth structure.<sup>4</sup> There was greater additional wear on low-fluorescence resin using FIT, due to its lower evidencing and greater difficulty in visualization and removal.

The third null hypothesis was also rejected, due to differences found when dental thirds were compared in the same condition. Cervical third is the main concerns during veneers removal due to its small volume of enamel, which can negatively influence the future restoration if removed;<sup>6,7</sup> however, the largest area of wear was found in incisal third for most study groups. Comparison and discussion with other works in literature becomes difficult, since there is a scarcity of studies that analyze the different dental thirds after direct resin veneers removal using FIT. This study used a long rounded conical diamond burr to remove composite resin veneers and it was supposed that the greater wear in this region may have been influenced by it. Therefore, the use of diamond burrs with a shorter length could assist in the removal of veneers without unnecessary tooth wear in incisal dental third.

Future studies should be effort to analyze the fluorescence of composite resins after aging, as their fluorescence may decrease over time and may negatively interfere with the effectiveness of FIT in removal of direct veneers.

## **6 CONCLUSION**

It was concluded that resin with a high intensity of fluorescence combined with FIT for removal of direct veneers promoted less tooth wear; however, FIT was unable to improve the veneer removal procedure in terms of presence of resin residues. The incisal third is most affected in direct veneer removal procedures. During the removal of direct veneers, teeth suffer more additional wear than presence of composite residue.

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## ATTACHMENT - Certificate from the Ethics Committee on the Use of Animals (CEUA)



UNIVERSIDADE ESTADUAL PAULISTA  
"JULIO DE MESQUITA FILHO"



CAMPUS ARAÇATUBA  
FACULDADE DE ODONTOLOGIA  
FACULDADE DE MEDICINA VETERINÁRIA

CEUA - Comissão de Ética no Uso de Animais  
CEUA - Ethics Committee on the Use of Animals

### CERTIFICADO

Certificamos que o Projeto de Pesquisa intitulado "A influência do grau de fluorescência de resinas compostas no retratamento de facetas diretas utilizando diferentes métodos de remoção", Processo FOA nº 0525-2021, sob responsabilidade de Ticiane Cestari Fagundes Tozzi apresenta um protocolo experimental de acordo com os Princípios Éticos da Experimentação Animal e sua execução foi aprovada pela CEUA em 24 de Setembro de 2021.

**VALIDADE DESTE CERTIFICADO:** 25 de Outubro de 2022.

**DATA DA SUBMISSÃO DO RELATÓRIO FINAL:** até 25 de Novembro de 2022.

### CERTIFICATE

We certify that the study entitled "The influence of the fluorescence intensity of composite resins on direct veneers retreatment using different removal methods", Protocol FOA nº 0525-2021, under the supervision of Ticiane Cestari Fagundes Tozzi presents an experimental protocol in accordance with the Ethical Principles of Animal Experimentation and its implementation was approved by CEUA on September 24, 2021.

**VALIDITY OF THIS CERTIFICATE:** October 25, 2022.

**DATE OF SUBMISSION OF THE FINAL REPORT:** November 25, 2022.

Prof. Associado João Carlos Callera  
Coordenador da CEUA  
CEUA Coordinator

CEUA - Comissão de Ética no Uso de Animais  
Faculdade de Odontologia de Araçatuba  
Faculdade de Medicina Veterinária de Araçatuba  
Rua José Bonifácio, 1193 - Vila Mendonça - CEP: 16015-050 - ARAÇATUBA - SP  
Fone: (16) 3636-3234 Email CEUA: ceua.foa@unesp.br